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AFRL-SR-BL-TR-01-

05266

1. REPORT DATE (DD-MM-YYYY) 10-10-2001		2. REPORT TYPE Final Technical		3. DATES COVERED (from - to) 01-04-2000 - 30-09-2001	
4. TITLE AND SUBTITLE (U) Apparatus for the Study of Shock Wave and Detonation Wave Interactions with Fuel Sprays				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER F49620-00-1-0196	
				5c. PROGRAM ELEMENT NUMBER 61103D	
6. AUTHOR(S)  Ronald K. Hanson				5d. PROJECT NUMBER 3484	
				5e. TASK NUMBER US	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  Stanford University Mechanical Engineering Department Stanford CA 94305-3032				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFOSR/NA 801 North Randolph Street Room 732 Arlington VA 22203-1977				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT  Approved for public release; distribution is unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT  Equipment listed in the report was purchased with \$126,457 DOD funding supplemented by \$14,050 Stanford University cost sharing. It will be used to investigate the interaction of shock waves and detonation waves with fuel sprays.					
15. SUBJECT TERMS shock waves, detonation waves, fuel sprays					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			Julian M. Tishkoff
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# **Apparatus for the Study of Shock Wave and Detonation Wave Interactions with Fuel Sprays**

## **DURIP/Instrumentation Grant Final Technical Report**

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### **EQUIPMENT ACQUIRED**

The equipment listed in Table 1, Shock/Detonation Wave – Spray Interaction Facility, was purchased with \$126,457 from AFOSR Contract F49620-00-1-0196 and \$14,050 from Stanford University Cost Sharing Accounts. This contract initially extended over the period 04/01/00 to 03/31/01 and was then extended to 09/30/01.

### **RESEARCH SUMMARY**

There is a critical need by computational fluids modelers for experiments that describe the interaction of well-characterized shock waves with very uniform fuel sprays. This data is needed to guide and validate CFD analyses of air-breathing propulsion systems with these flow elements, such as pulse detonation engines. There are, to our knowledge, no currently operating facilities with the capability to address these fundamental heterogeneous flows using modern optical diagnostics.

The test apparatus purchased will enable investigations of the interaction of shock waves and detonation waves with fuel sprays. The newly acquired shock tube, vacuum support and instrumentation, when used in conjunction with existing diagnostics, will permit the generation of shock waves and detonation waves and their accurate characterization. The real time droplet sizing system will permit accurate quantification of the fuel spray generation process, as well as determination of the post-shockwave spray distribution time history.

Using this new equipment, researchers at Stanford, will now be able to provide details on the attenuation, or growth, of shock waves as they travel through a two-phase flow, details on the spray evaporation time history, and details on the chemical kinetics of the ignition process. This will expand the range of our current studies, as previous experiments in our laboratory have only been able to investigate gas-phase chemistry, and this will expand the available shock tube database from other laboratories, as previous experiments in other laboratories have not concentrated on the production of very uniform fuel sprays in shock tubes.

In addition to the work in Prof. Hanson's group, other researchers in the High Temperature Gasdynamics Laboratory who are working with sprays, including Professors

C. Edwards' and T. Bowman's studies sprays in detonations and meso-arrays, will benefit from the availability of the portable state-of-the-art spray sizer, and the experience in optical diagnostics in two-phase flows gained in the shock tube studies.

TABLE 1: Shock/Detonation Wave Spray Interaction Facility

<i>Item</i>	<i>Supplier</i>	<i>Cost (\$)</i>
<b>Spray Interaction Shock Tube</b>		
Shock Tube	Johansing Ironworks	47,652
End mass and windows	HTGL Shops	21,008
Vacuum support including: linear feed through, gate valves, pumps	Kurt J. Lesker, MDC Vacuum, Varian Vacuum	15,614
Instrumentation including: pressure transducer and gauges	Kistler Instruments, McMaster Carr, MKS Instruments	6,553
<b>Droplet Sizer</b>		
Spraytec RTS5114 real time droplet sizing system	Malvern Instruments	49,680
<b>TOTAL</b>		<b>\$140,507</b>